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Adaptation of an epistemological belief instrument towards chemistry and chemistry lessons

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Abstract

The purpose of this study was adapting an instrument into Turkish which is developed by a research group in California University for identifying pre-service science teachers' epistemological beliefs toward chemistry. The adapted instrument is a likert type instrument with five scales, includes 18 items and it was applied to 100 pre-service sicence teachers to determine their epistemological beliefs in 2009-2010 spring semester. The reliability of the instrument was found as .59. It was concluded that this adapted instrument can be used to determine teachers' and students' epistemological beliefs toward chemistry.

Keywords: epistemological beliefs; pre-service teachers; chemistry education; epistemology; adaptation.

1. Introduction

Epistemology is an area of philosophy which deals with source, content and nature of knowledge. Learners have epistemological beliefs which are related with the source, content, and nature of knowledge (Chan & Elliott, 2004; Duell & Schommer-Aikins, 2001). Through this point, it is obvious that epistemological beliefs affect the process of learning and teaching. These beliefs also make it difficult to learn chemistry which is one of the problematic science areas in terms of learning and teaching

Some researchers has been conceptualized the epistemological beliefs. Perry (1968) explained the epistemological beliefs as the positions which are dualism, multiplism, relativism, and commitment (as cited in Schommer, 1994). Belenky, Clinchy, Goldberger, and Tarule (1986) examined these beliefs five different perspectives which are silence, received knowledge, subjective knowledge, procedural knowledge, and constructed knowledge (as cited in Schommer, 1994). Schommer (1990) classified epistemic belief system as the omniscient* authority, certain knowledge , simple knowledge, quick learning, and fixed ability. Hofer and Pintrich (1997) conceptualized these beliefs as the certainty of knowledge (stability), simplicity (structure) of knowledge, source of knowing (authority), and justification for knowing (evaluation of knowledge claims). Brownlee (2004) examined epistemological beliefs with the titles of students' beliefs which are about what knowledge is, how it can be gained, certainty degree of knowledge, the limits and criteria to find out knowledge.

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Research on epistemological beliefs has been an interested research area in recent years (Elby, 2001; Schommer, 1990). It can be stated that these studies are classified with three titles. First, the study on students' personal epistemology has examined the nature of development and change in epistemological beliefs (Chai, Khine, & Teo, 2006; Conley, Pintrich, Vekiri, & Harrison, 2004; Schommer, 1990). Second, the research on epistemological beliefs has examined how these beliefs can facilitate or restrict student understanding, reasoning, thinking, learning, and achievement (Brownlee, Perdie, & Lewis, 2001; Pulmones, 2010). Third, the study on teachers' epistemological beliefs has investigated the nature of teachers' epistemological beliefs (Haswesh, 1996).

Researchers conducted with elementary students (Conley, Pintrich, Vekiri, & Harrison, 2004), high school students (Elby, 2001; Qian & Alvermann, 1995), and pre-service teachers (Brownlee, Purdie, & Lewis, 2001; Chan & Elliot, 2004) in order to determine students' epistemological beliefs. In these studies, epistemological beliefs of students were determined using likert type questionnaires.

Schommer (1990) conducted an empirical study using a 63-item questionnaire in order to examine the epistemological beliefs of undergraduates in the USA. She used factor analysis in order to determine constructs of epistemology questionnaire and four factors which are certain knowledge, simple knowledge, quick learning, and fixed/innate ability were determined in the analysis.

Elby (2001) conducted a study in order to develop high school students' epistemological beliefs. For this aim, instructional practices and curricular elements were used during the semester and the EBAPS and the MPEX surveys were administered both at the beginning of the study and at the end of the study. Sample of the study was consisted of 82 students. Students achieved significant gain scores in terms of EBAPS survey.

Chan and Elliot (2004) surveyed 385 Hong Kong pre-service teachers using the Epistemological Beliefs Questionnaire (EBQ) and the Teaching and Learning Conception Questionnaire. They identified four epistemological beliefs dimensions which are innate/fixed ability, learning effort/process, authority/expert knowledge, and certainty knowledge and two teaching learning and teaching dimensions which are traditional and constructivist conception.

Chai, Khine, & Teo, (2006) searched 537 Singapore pre-service teachers' epistemological beliefs. They used the epistemological beliefs questionnaire adapted from Schommer's 63-item questionnaire in order to see the profiles of pre-service teachers' epistemological beliefs and understand whether pre-service teachers' epistemological beliefs are significantly influenced by gender, subject matter, and teaching experience. Their questionnaires included four dimensions which are innate/fixed ability, learning effort/process, authority/expert knowledge, and certainty of knowledge. They resulted that the dimensions of innate/fixed ability, authority/expert knowledge, and certainty of knowledge were different from each other in terms of gender.

It is important to determine teachers' and students' epistemological beliefs toward chemistry. Identification of pre-service teachers' epistemological beliefs toward chemistry should help researchers to have an idea about how the teachers' and students' epistemological beliefs will be in the future since today's pre-service teachers will be the teachers of the future. For this reason, an instrument determining pre-service teachers' epistemological beliefs towards chemistry is needed. The purpose of this study is based on overcoming this need. Research question of this study is "What are the epistemological beliefs held by the Turkish pre-service science teachers?"

2. Method

Epistemological Beliefs Assessment for Physical Science (EBAPS) was developed by a research group at the University of California, Berkeley (White, Elby, Frederiksen, & Schwartz, 1999). The EBAPS was used to determine high school students' epistemological beliefs at the science classrooms. This questionnaire was made up of three parts. Part I included 17 statements to be rated from A (strongly agree) to E (strongly disagree) depending upon the participants' beliefs. Part II contained six questions in a multiple-choice format founded on context specific scenarios. Part III had seven questions in a multiple choice format based on an exchange of dialogues in context-specific cases amongst students.

White et al (1999) thought that The EBAPS has five dimensions which are structure of scientific knowledge (SSK), nature of knowing and learning (NKL), real- life applicability (RLA), evolving knowledge (EK), and source of ability to learn (SAL).

White et al (1999) scored each item in the EBAPS on a scale of 0 (least sophisticated) to 4 (most sophisticated). A mean score for each dimension was calculated from the students' average score on each item in a subscale.

In this study, EBAPS, which was developed, was adapted by researchers by the way of one-way translation and Epistemological Beliefs Instrument towards Chemistry (EBIC) was constructed to determine epistemological beliefs of pre-service science teachers toward chemistry and chemistry lessons. First, the EBIC was translated from English to Turkish by researchers. Some items of the instrument were dropped since they are inappropriate to chemistry and chemistry lessons according to the expert' opinions. The Turkish form of the EBIC and related items in the original of the EPABS instrument were checked over by 5 science education experts. According to the feedbacks, the researchers produced the final form of the EBIC. The adapted instrument is a Likert-type instrument with five scales, includes 18 items and it was applied to 100 pre-service science teachers (21 elementary science teachers, 46 physics teachers, and 33 chemistry teachers) to determine their epistemological beliefs and to calculate reliability of instrument in 2009-2010 spring semester in a university in Turkey.

3. Results

In this study, the translated instrument which explores pre-service teachers' epistemological beliefs toward chemistry and chemistry lessons had a 5-point Likert-type; the responses of students were recorded according to 5-point Likert type scale- based on White et al (1999). Scoring of each item was made on a scale of 0 (least sophisticated) to 4 (most sophisticated). Table 1 shows the items and scoring of items.

Table1. Items and scoring of items in the EBIC

	Items	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	When it comes to understanding chemistry, remembering facts isn't very important.	0	1.5	2.5	3.5	4
2	Ayse just read something in her science textbook that seems to disagree with her own experiences. But to learn science well, Tamara shouldn't think about her own experiences; she should just focus on what the book says.	4	3	1	0.5	0
3	Teaching does not remind her of how much she already knows. It helps a teacher understand the material better.	0	1	2	3	4
4	Scientists perform experiments about chemical phenomena and to explain these experiments, they produce a theory on them. However, it is need to discuss on theory, there is no absolute truth regarding that theory.	0	1	2	3	4
5	If someone is having trouble in chemistry class, studying in a better way can make a big difference.	0	1	2	3	4
6	Someone who doesn't have high natural ability can still learn the material well even in a hard chemistry class.	0	1	2	3	4
7	Often, a scientific principle or theory just doesn't make sense. In those cases, you have to accept it and move on, because not everything in science is supposed to make sense.	0	1	2	3	4
8	Given enough time, almost everybody could learn to think more scientifically, if they really wanted to.	0	1	2	3	4

	Items	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
9	When learning science, people can understand the material better if they relate it to their own ideas.	0	0.5	1	3	4

10	Science is a little like fashion; something that's "in" one year can be "out" the next. Scientists regularly change their theories back and forth.	0	1	2	4	4
11	To be successful at science, hard work is much more important than inborn natural ability.	0	1	2	3	4
12	To understand chemistry, the formulas (equations) are really the main thing; the other material is mostly to help you decide which equations to use in which situations.	4	3	1.5	0.5	0
13	Science applies to almost all real-world experiences. If we can't figure out how earthquakes occur, it's because the stuff is very complicated, or because we don't know enough science yet.	0	1	2	4	4
14	The textbook was written by people who know science really well. Putting things in your own words help you learn You should not learn things the way the textbook presents them.	0	1	2	4	4
15	A good science textbook should show how the material in one chapter relates to the material in other chapters. It shouldn't treat each topic as a separate "unit," because they're not really separate.	0	1	2	4	4
16	Some scientists think the dinosaurs died out because of volcanic eruptions, and others think they died out because an asteroid hit the Earth. Maybe the evidence supports both theories. There's often more than one way to interpret the facts.	0	1	2	3	4
17	Getting the right answer without really understanding what it means does not make sense.	0	1	2	3	4
18	Understanding science is really important for people who design rockets, but not important for politicians.	4	3	2	1	0

The original form of the instrument was made up of three parts before the adaptation process. The researchers analyzed and translated each item into Turkish whereas some items were found to be inappropriate for chemistry context. For this reason, 18 items needed to be modified and other items were dropped out from the study.

There were five dimensions in the original instrument which are also taken as a base in the adapted version of this instrument. Dimension of structure of scientific knowledge (SSK) included items 1,7,12,14,16,17. Dimension of nature of knowing and learning (NKL) involved in items 2,3,9,15,18. At real- life applicability (RLA), there was two items which are 13, and 19. Also, dimension of evolving knowledge (EK) included item four and item ten. Finally, dimension of source of ability to learn (SAL) involved in items 5, 6, 8, 11.

The content validity after the final form of the test had been developed was found to be 80% agreement between the researchers. The reliability of the instrument had been found as .59.

4. Conclusion

Identification of pre-service teachers' epistemological beliefs toward chemistry should help researchers to have an idea about how the teachers' and students' epistemological beliefs will be in the future since today's pre-service teachers will be the teachers of the future. Instructors should know pre-service teachers' beliefs in the context of chemistry and chemistry lessons. Also, in order to construct good quality chemistry lessons, it is crucial to determine pre-service science teachers' beliefs toward chemistry. Since the reliability of the instrument was found to be .59, it was concluded that this adapted instrument can be used to determine teachers' and students' epistemological beliefs toward chemistry and chemistry lessons (Pulmones, 2010).

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